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Development of Overlength Forms for a New Enlistment Screening Test

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Development of Overlength Forms for a New Enlistment Screening Test

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ABSTRACT

Overlength forms, containing about 50 percent more items than needed in the final forms, have been developed for a new Enlistment Screening Test. These forms were constructed using items from discontinued forms of the DOD's test batteries. This research memorandum describes the data analyses and their results.

EXECUTIVE SUMMARY

The Enlistment Screening Test (EST) is used by military recruiters to predict how a potential applicant is likely to score on the Armed Forces Qualification Test (AFQT). Persons with low EST scores can be screened out as being unlikely to pass the AFQT standard. Persons with high EST scores can be encouraged to apply by describing available incentives such as bonuses and enlistment guarantees.

A new EST has been developed because the Marine Corps felt that the previous EST had become obsolete. The development had two stages: In the first stage, two overlength forms (containing about 50 percent more test items than needed in the final forms) were constructed from items in discontinued versions of the DOD's test batteries. In the second stage, data on overlength forms were used to select items for the final forms. This research memorandum describes the first of these two stages.

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INTRODUCTION

The Enlistment Screening Test (EST) is used by military recruiters to predict how a potential applicant is likely to score on the Armed Forces Qualification Test (AFQT). Persons with low EST scores can be screened out as being unlikely to meet the AFQT standard. Persons with high EST scores can be encouraged to apply by describing available incentives such as bonuses and enlistment guarantees.

A new EST has been developed because the Marine Corps felt that the previous EST had become obsolete. The development had two stages. In the first stage, two overlength forms (containing about 50 percent more test items than would be needed in the final forms) were constructed. In the second stage, data on overlength forms were used to select items for the final forms. This research memorandum describes the first of these two stages.

CONTENT OF THE EST

Since January 1989, the AFQT has consisted of the Word Knowledge (WK), Paragraph Comprehension (PC), Arithmetic Reasoning (AR), and Mathematics Knowledge (MK) subtests of the Armed Services Vocational Aptitude Battery (ASVAB). For optimum prediction of AFQT scores, the content of the EST should resemble that of the AFQT as much as practicable. PC was excluded because it takes three times as long per item as WK does, while measuring almost the same construct. Given the time limit of about 45 minutes specified in the Marine Corps request, the author decided that the verbal part of the new EST would consist of 35 WK items (the same number as in the ASVAB), and the math part would contain 30 AR and MK items (the same number as in AR). The ratio of AR and MK items was not preset; the numbers of these items were to depend on the results of the item selection procedure, in which AR and MK would be treated as measuring the same trait. The overlength forms were to contain 55 verbal and 45 math items so that at least a third of the items would be deleted while creating the final forms.

With permission from the Joint Service Selection and Classification Working Group, items were taken from discontinued forms of the ASVAB and the AFQT. These forms were ASVAB 5X, 6X, 7X, 6E, 7E, and AFQT7A. Since items in these forms had already undergone screening, item quality was not a concern in the present study. No evaluation of item content was performed. The analyses were aimed at selecting items with the proper level of difficulty and with high discriminating power. The goal was to predict AFQT scores as accurately as possible, emphasizing AFQT percentile ranks of 31 and 50, which are the lower-end points of AFQT Categories IIIB and IIIA.

Table 1 presents the numbers of items and examinees available for item-level analyses. Data on ASVAB Forms 5X, 6X, and 7X came from a norming study conducted by the Air Force Human Resources Laboratory

(AFHRL) in fall 1975. These data were provided to CNA by AFHRL on a computer tape. The CNA data were collected in a study by Sims and Truss [1]. Although Forms 6E and 7E contained MK, no data were available for these items. There was no MK in AFQT7A. All the items were supposed to be different from one another, but one item was found in two forms. Score-level data from the CNA study were available for ASVAB Forms 6X and 7X on 1,114 and 2,394 recruits.

Table 1. Sources of item-level data

Form	Subtest WK	Subtest AR	Subtest MK	Data Source	Sample Size
ASVAB 5X	30	20	20	AFHRL	1,671
ASVAB 6X	30	20	20	AFHRL	1,806
ASVAB 7X	30	20	20	AFHRL	1,662
ASVAB 6E	30	20		CNA	1,756
ASVAB 7E	30	20		CNA	1,773
AFQT 7A	25	25		CNA	3,530

ITEM RESPONSE THEORY

Items in each form had data from a different sample. This is not a problem when the samples are equivalent, i.e., come from the same population. However, two groups of samples, AFHRL samples for 5X/6X/7X and CNA samples for 6E//E/AFQT7A, came from different populations. Therefore, these items from different groups could be compared only by using a theoretical model. Such a model is available in Item Response Theory (IRT) [2]. IRT assumes that all items in all forms of a given subtest measure the same ability θ. The probability of answering an item correctly is given by a three-parameter logistic function of θ as follows:

$$P(\theta) = c + (1-c)/[1 + \exp(1.7\ a\ (b-\theta))] \quad , \qquad (1)$$

where "exp" is the exponential function, and the parameters a, b, c vary from one item to another. The parameter "a" represents the discriminating power of the item, i.e., how sensitive it is to change in ability. Parameter "b" represents the difficulty of the item, while "c" is the lower asymptote of the function.

The logistic form, rather than some other function, is used for mathematical and computational convenience; the crucial assumption, which makes it possible to use data on different items from different

samples, is that all the items measure the same ability. Item parameters estimated from nonequivalent samples must be linked, i.e., placed on a common scale. This usually requires that some items be common to the two sets of forms. No such common items were available; therefore, as described in the following section, an unorthodox method had to be developed for linking parameter estimates.

LINKING PARAMETER ESTIMATES

For each form of every subtest, IRT item parameters were estimated using the LOGIST program [3]. LOGIST sets the scale of the a and b parameters by assuming that the distribution of ability in the sample has zero mean and unit variance. Hence, when samples for two forms are equivalent, parameter estimates for the two forms are automatically on the same scale, except for random error. No further adjustment is needed in such a case. When samples are not equivalent, linear transformations are needed to place difficulty and discrimination estimates for one form on the same scale as estimates for another form. Items cannot be compared with one another unless their parameters are on a common scale. The transformation from parameters a and b on the LOGIST scale to a* and b* on the common scale is given by

$$a^* = a/A \quad \text{and} \tag{2a}$$

$$b^* = A\,b + B \quad , \tag{2b}$$

where the constants A and B are the same for all items.

In the linkage step of the calculations, the goal was to place item parameters for all forms on the scale of Form 8A in the 1980 reference sample. This is a nationally representative stratified sample of individuals, in the age range 18 to 23, who were administered Form 8A of the ASVAB in 1980. ASVAB norms, including percentile ranks of AFQT scores, are based on this sample; for detailed information see Maier and Sims [4]. Form 8A item parameters using the 1980 data have been estimated by Bock and Mislevy [5].

The importance of the 1980 scale of Form 8A arises from the Marine Corps specifications for the new EST. The ultimate goal was to select items that would best predict AFQT scores near the 31st and 50th percentiles in the 1980 reference sample. Such item selection can only be done after parameters of all available scores are on the 1980 scale of Bock and Mislevy.

In most applications of IRT, different item calibrations are linked using items common to both forms. No such items were available in the present study. The links available were the linear equatings of total scores on different forms. The linking procedure used in the study is

as follows: Distribution of ability in the reference population is assumed to be standard normal. Given this assumption and the Bock-Mislevy item parameters, mean and variance of Form 8A scores in the reference sample are calculated. From these and the equating relationship, the "equating-based" mean and variance of Forms 6X/7X in the 1980 sample are calculated. For given values of A and B in equations (2a) and (2b), one can use the transformed parameters a* and b* to compute the "IRT-based" mean and variance of 6X/7X scores. Iterative calculations are used to find those values of A and B that make the IRT-based statistics equal to the equating-based values. A similar procedure is then also used for Forms 6E/7E. These calculations are performed separately for each subtest. The results are summarized in table 2.

Table 2. Results of linking item parameters

Forms	Data for equating and forms equated	Transformation coefficients A			B		
		AR	WK	MK	AR	WK	MK
6X/7X	Truss, Hiatt & Sims [6] 8A to 6X/7X	.91	.89	.92	-.11	-.05	-.09
6E/7E	Sims and Truss [1] 6X/7X to 6E/7E	.75	.70	[a]	.01	.13	[a]

a. No data on Math Knowledge items in Forms 6E/7E

Table D-1 of a CNA study by Truss, Hiatt, and Sims [6] provides means and standard deviations of forms 6X and 7X combined, and of form 8A, in a sample of 2,025 applicants. For each subtest, these statistics yield a linear conversion of 8A standard scores (SSs) into equivalent raw scores on forms 6X/7X. As an example, for AR, this conversion is given by

$$[\text{RAW}(6X/7X) - 12.7]/4.7 = [\text{SS}(8A) - 49.3]/10.0 \quad , \tag{3a}$$

which yields

$$\text{RAW}(6X/7X) = .47\ \text{SS}(8A) - 10.5 \quad . \tag{3b}$$

Using this conversion, and mean and variance of 8A standard scores in any group of people, mean and variance of 6X/7X raw scores can be calculated for that group. (It is assumed that the same equating holds in all populations. The notation 6X/7X means that these two forms were treated as a single form in [6]. Therefore, the mean and variance in any group computed from the equating are the values that would be obtained on administering each of these forms to half the group. This method of combining the forms was maintained in all later calculations.)

Following the assumption used frequently in item calibration programs, the ability distribution in the 1980 reference sample (Bock and Mislevy's calibration sample) was taken to be standard normal. Using Bock and Mislevy's item-parameter estimates, mean and variance of 8A raw scores in this sample were calculated by numerical integration. The θ values and weights needed for the 20-point Gauss-Hermite integration were taken from Abramowitz and Stegun [7]. At each of these θ values, probabilities $P(\theta)$ for the test items were used to compute the true score and θ-conditional error variance of the entire subtest at that ability. The mean of the observed subtest scores in the entire group equals that of true scores. Variance of observed scores equals that of true scores plus the average of the conditional error variances. (Form 8A mean and variance were calculated using IRT, instead of using actual sample values, because computed and actual values may differ somewhat as a result of violations of IRT assumptions. For linking IRT scales, computed values are the appropriate ones.)

Using the official linear conversion (see [4]), mean and variance of raw 8A scores were converted to mean and standard deviation of standard scores, which came out to 49.3 and 10.0. From these, and the linear equating given previously, the equating-based mean and sigma of Arithmetic Reasoning Forms 6X/7X turned out to be 12.7 and 4.7. These were the values to be reproduced by using IRT and numerical integration over a standard normal distribution of ability. Using an iterative, interactive computer program, the coefficients A and B of equations (2a,b) were adjusted so that the mean and sigma computed from IRT equaled the equating-based values. The resulting transformation of Arithmetic Reasoning 6X/7X item parameters was

$$a \rightarrow a/0.91, \quad b \rightarrow 0.91\, b - 0.11 \quad . \tag{4}$$

These transformed parameter estimates were on the 1980 Bock-Mislevy scale. The same transformation was also applied to Form 5X because its calibration sample was equivalent to the 6X and 7X samples. The transformations for the other two subtests were

$$a \rightarrow a/0.89, \quad b \rightarrow 0.89\ b - 0.05 \tag{5}$$

for Word Knowledge, and

$$a \rightarrow a/0.92, \quad b \rightarrow 0.92\ b - 0.09 \tag{6}$$

for Mathematics Knowledge.

Similarly, the equating of 6E/7E to 6X/7X was used to place the 6E/7E item parameters on the 1980 scale. Data from the CNA study [1] included 6X/7X subtest scores and 6E/7E item responses. The necessary means and sigmas, and hence the linear equatings, were computed from these data. For the AR subtest, the 6X/7X mean and sigma, plus the equating, led to 6E/7E mean and sigma of 11.7 and 4.6 in the 1980 sample. To reproduce these values from numerical integration, the necessary transformation of item parameters was

$$a \rightarrow a/0.75, \quad b \rightarrow 0.75\ b + 0.01 \ . \tag{7}$$

The transformation for Word Knowledge was

$$a \rightarrow a/0.70, \quad b \rightarrow 0.70\ b + 0.13 \ . \tag{8}$$

There was no Mathematics Knowledge in the CNA data. The same conversions were also used for AFQT7A.

ITEM SELECTION

Once all item parameters had been placed on the 1980 metric, item selection was straightforward. The item information function [2] indicates how well an item measures ability at any given level. The information function is given by

$$I(\theta) = (dP(\theta)/d\theta)^2 \ / \ [P(\theta)\{1-P(\theta)\}] \ . \tag{9}$$

The emphasis in construction of the EST was on the 31st and 50th percentiles. In the standard normal distribution, these are θ values of -0.5 and 0. Therefore, for each item, information functions were computed at these two values and added. The total information, i.e., the sum I(-.5)+I(0), was taken as the measure of the desirability of an item. For the Math part of the EST, AR and MK items were combined during item selection, although they were analyzed separately during the IRT analyses.

For each part of the EST, all items were sorted in descending order by total information. Then, in each pair of successive items, one was assigned to Form A and the other to Form B, using a uniform random variable. This made the two forms equivalent in total information, and therefore probably equivalent in their ability to predict the AFQT.

The items in a form should be printed with the easiest items first and the most difficult items last. Therefore, for each item the percentage of correct answers (i.e., $P(\theta)$ times 100) was computed at θ values of -.5 and 0. These values were grouped into intervals of 5 points (i.e., 0 to 4.99, 5 to 9.99, etc.). These groups were denoted by G31 and G50 for θ of -.5 and 0. Items in a form were sorted in descending order by G31. Within each G31 group, they were again sorted by G50. In the ordering of items, therefore, difficulty at the 31st percentile had precedence over difficulty at the 50th percentile. Thus, four ordered lists of items were prepared: two content areas, verbal and math, in each of Forms A and B. These lists, and copies of the old DOD tests from which the items were taken, were provided to Headquarters, Marine Corps (HQMC). HQMC typed and printed the overlength forms. These were distributed to Marine Corps recruiters in May 1987.

Lists of the selected items are presented in tables 3 to 6. The item "code" shows the form from which the item was taken, and its position in that form. In the math part, the code also shows the subtest, AR or MK, of the item. The "percentage correct" values are percentages of correct answers to be expected at the 31st and 50th percentiles of ability. These are followed by the discrimination ("a"), difficulty ("b"), and guessing ("c") parameters of the item on the 1980 scale. Finally, the "information" columns contain the values I(-.5) and I(0) of the information function as defined in equation (9).

DISCUSSION

The AFHRL data on ASVAB Forms 5X, 6X, and 7X came from the study that led to the ASVAB misnorming of 1976. A detailed analysis of the misnorming by Maier and Truss [8] has shown that the misnorming had three causes: incorrect scoring of the reference test, coaching on the reference test, and deletion of some examinees who scored low on the reference test. The ASVAB data themselves, however, were satisfactory.

The analyses in the study were driven by the need to use available data to construct the overlength forms. These data came from two different samples four years apart, and did not contain any scores on the current AFQT. This made using the IRT unavoidable, even though its assumptions may not be strictly valid. No tests of the assumptions were made because, even if the tests had shown the assumptions to be invalid, there was no alternative to using the IRT. Similarly, an unorthodox procedure based on equating was used to link the scales of the three calibrations (of AFHRL, CNA, and 1980 data) because no better option existed. The overlength forms were eventually administered to applicants in all four services. Analyses of those data will be reported in another research memorandum.

Table 3. Characteristics of verbal items in Form A

Item	Code	Percentage correct 31	50	IRT parameters a	b	c	Information 31	50
1	6X 3	86	94	1.87	-1.35	0.15	0.40	0.20
2	7X 9	82	93	1.98	-1.19	0.13	0.53	0.27
3	7X 3	84	93	2.02	-1.23	0.13	0.52	0.25
4	5X 4	79	95	3.45	-0.86	0.07	1.88	0.51
5	6X 7	78	95	3.24	-0.82	0.18	1.57	0.52
6	6E 5	77	92	2.50	-0.92	0.11	1.03	0.45
7	7E 5	78	93	2.62	-0.91	0.15	1.06	0.45
8	6X 6	74	92	2.88	-0.72	0.25	1.24	0.60
9	7X 5	72	90	2.46	-0.82	0.11	1.10	0.55
10	6E 6	71	86	1.89	-0.88	0.11	0.67	0.42
11	5X 7	71	87	2.08	-0.84	0.13	0.78	0.47
12	5X 6	74	88	1.87	-0.97	0.13	0.60	0.36
13	7A34	67	95	4.59	-0.59	0.18	3.71	1.01
14	7X 6	67	90	3.32	-0.55	0.28	1.59	0.90
15	6X 8	69	89	2.99	-0.56	0.31	1.22	0.78
16	5X 8	66	80	1.52	-0.79	0.13	0.44	0.35
17	7E 7	61	79	1.89	-0.58	0.15	0.67	0.54
18	7A68	61	77	1.51	-0.75	0.04	0.51	0.40
19	7A65	65	79	1.51	-0.86	0.04	0.49	0.36
20	7X12	57	83	2.92	-0.48	0.16	1.53	1.09
21	7E 6	57	82	3.35	-0.26	0.38	0.80	1.25
22	7X13	56	77	2.19	-0.44	0.17	0.83	0.75
23	7A33	58	72	1.24	-0.70	0.04	0.35	0.30
24	7X11	51	75	2.50	-0.31	0.20	0.89	0.99
25	6E12	49	80	3.50	-0.31	0.23	1.45	1.66

Table 3. (Continued)

Item	Code	Percentage correct 31	50	IRT parameters a	b	c	Information 31	50
26	7A36	46	76	2.99	-0.33	0.13	1.49	1.47
27	6X10	50	73	2.86	-0.16	0.31	0.61	1.12
28	5X14	47	67	1.87	-0.22	0.16	0.54	0.64
29	5X15	47	66	2.10	-0.07	0.26	0.41	0.66
30	7X18	47	68	2.02	-0.23	0.16	0.62	0.74
31	6X17	44	68	2.46	-0.17	0.19	0.73	1.04
32	5X13	41	65	2.23	-0.17	0.13	0.74	0.96
33	6X15	41	64	3.81	0.04	0.33	0.28	1.75
34	7X17	42	61	2.96	0.12	0.33	0.23	0.97
35	7E15	40	56	1.63	0.03	0.15	0.35	0.49
36	6E14	36	82	4.86	-0.27	0.15	2.58	3.21
37	7E11	39	66	2.79	-0.13	0.18	0.81	1.38
38	7A52	39	69	3.62	-0.09	0.25	0.70	2.03
39	6E15	36	64	3.06	-0.08	0.18	0.80	1.66
40	6X18	39	58	3.05	0.13	0.30	0.24	1.09
41	6X16	39	52	3.76	0.29	0.36	0.05	0.83
42	6E20	31	58	4.86	0.06	0.27	0.19	3.07
43	7X16	32	54	3.49	0.12	0.24	0.28	1.63
44	7X20	33	44	3.80	0.36	0.30	0.04	0.75
45	7X26	31	44	1.89	0.43	0.19	0.17	0.43
46	7A66	28	53	4.86	0.10	0.24	0.16	3.05
47	7A82	28	45	4.06	0.25	0.25	0.09	1.45
48	7A51	30	40	3.55	0.42	0.27	0.04	0.62
49	6X20	29	44	3.81	0.31	0.26	0.07	1.07
50	6E 8	26	39	4.86	0.29	0.24	0.03	1.39
51	6X23	23	40	3.05	0.31	0.17	0.18	1.07
52	5X22	21	39	3.74	0.26	0.16	0.16	1.64
53	7X23	24	35	3.81	0.39	0.21	0.05	0.88
54	6X24	23	35	2.23	0.52	0.15	0.15	0.52
55	7E23	19	34	2.43	0.43	0.10	0.23	0.80

Table 4. Characteristics of verbal items in Form B

Item	Code	Percentage correct		IRT parameters			Information	
		31	50	a	b	c	31	50
1	7A 3	91	98	2.89	-1.30	0.04	0.65	0.18
2	6E 2	87	98	3.62	-0.99	0.11	1.43	0.31
3	6X 5	87	94	1.93	-1.37	0.15	0.41	0.19
4	6E 3	84	97	3.45	-0.95	0.11	1.49	0.37
5	7A20	81	95	2.89	-0.99	0.04	1.24	0.41
6	6E 1	82	93	2.26	-1.11	0.11	0.71	0.31
7	6E 4	76	96	3.86	-0.76	0.11	2.50	0.63
8	5X 5	78	94	2.97	-0.85	0.17	1.34	0.50
9	6X 4	80	93	2.69	-0.81	0.33	0.90	0.43
10	7E 3	79	92	2.38	-0.99	0.15	0.84	0.38
11	7A19	75	87	1.65	-1.14	0.04	0.49	0.30
12	7E 1	80	90	1.60	-1.22	0.15	0.38	0.23
13	7A17	72	90	2.50	-0.86	0.04	1.21	0.56
14	5X 9	73	90	2.56	-0.71	0.26	0.98	0.56
15	6E 9	70	86	1.94	-0.85	0.11	0.71	0.44
16	7A18	73	90	2.36	-0.90	0.04	1.06	0.51
17	7X 8	71	84	1.56	-0.95	0.13	0.44	0.31
18	7E 4	66	86	2.55	-0.65	0.15	1.21	0.72
19	5X 3	65	90	3.28	-0.59	0.19	1.87	0.94
20	7X 7	67	87	2.56	-0.66	0.18	1.15	0.69
21	6X 9	69	89	2.71	-0.69	0.18	1.27	0.67
22	7X10	66	80	1.56	-0.79	0.13	0.47	0.36
23	6E16	66	82	1.75	-0.77	0.11	0.60	0.43
24	5X10	62	87	3.36	-0.43	0.32	1.34	1.11
25	5X11	62	78	1.68	-0.66	0.13	0.55	0.44
26	7E 8	64	77	1.34	-0.73	0.15	0.33	0.29
27	5X12	58	84	3.11	-0.41	0.26	1.30	1.14
28	6E11	60	77	1.73	-0.62	0.11	0.60	0.49
29	7X14	55	80	2.92	-0.34	0.27	1.02	1.12
30	6X13	52	68	2.73	0.07	0.42	0.21	0.71
31	7E17	48	84	4.23	-0.31	0.25	1.82	2.11
32	7E 9	50	75	3.01	-0.20	0.29	0.77	1.27
33	6E10	48	71	2.45	-0.22	0.22	0.72	0.97
34	7E12	48	67	3.26	0.07	0.40	0.21	1.04
35	5X16	49	64	1.39	-0.24	0.13	0.34	0.38

Table 4. (Continued)

Item	Code	Percentage correct		IRT parameters			Information	
		31	50	a	b	c	31	50
36	7E10	42	74	3.69	-0.17	0.25	0.96	2.05
37	6X14	41	67	2.94	-0.10	0.22	0.72	1.41
38	5X17	44	61	2.17	0.09	0.29	0.28	0.61
39	7A50	43	63	2.94	0.06	0.32	0.30	1.06
40	7E14	42	61	1.82	-0.08	0.15	0.46	0.62
41	7A49	44	62	1.46	-0.28	0.04	0.47	0.48
42	7X21	43	58	1.37	-0.03	0.13	0.30	0.36
43	6X12	37	71	3.81	-0.14	0.21	1.02	2.38
44	6E 7	37	59	2.99	0.06	0.25	0.39	1.28
45	6X11	39	59	2.97	0.11	0.29	0.27	1.09
46	7A67	37	57	2.67	0.12	0.25	0.31	0.97
47	5X18	39	58	2.31	0.06	0.22	0.39	0.82
48	7A35	33	79	4.59	-0.25	0.11	2.56	3.31
49	7X15	32	59	3.81	0.05	0.24	0.37	2.13
50	5X20	31	43	3.81	0.37	0.29	0.04	0.75
51	5X19	28	58	3.81	0.00	0.17	0.63	2.58
52	7E16	28	56	3.23	0.02	0.15	0.65	1.91
53	6E21	24	43	3.28	0.26	0.18	0.20	1.30
54	7E19	21	37	4.86	0.25	0.19	0.06	2.03
55	7X25	18	29	3.81	0.46	0.16	0.04	0.81

Table 5. Characteristics of math items in Form A

Item	Code	Percentage correct		IRT parameters			Information	
		31	50	a	b	c	31	50
1	AR7A21	80	91	1.85	-1.17	0.09	0.53	0.29
2	AR7A39	73	86	1.69	-1.00	0.09	0.53	0.34
3	AR7A 8	69	92	3.36	-0.67	0.13	2.11	0.83
4	MK6X89	67	86	2.41	-0.65	0.19	1.01	0.65
5	AR7A22	68	84	1.85	-0.82	0.09	0.68	0.45
6	AR7A37	61	89	3.43	-0.54	0.17	2.12	1.12
7	MK6X90	63	82	2.14	-0.56	0.21	0.76	0.60
8	MK7X90	62	84	2.49	-0.60	0.13	1.20	0.78
9	AR5X49	61	74	1.37	-0.56	0.18	0.33	0.31
10	MK6X72	59	84	2.74	-0.52	0.17	1.34	0.94

Table 5. (Continued)

Item	Code	Percentage correct		IRT parameters			Information	
		31	50	a	b	c	31	50
11	AR7A23	53	80	2.60	-0.50	0.07	1.46	1.04
12	AR6E35	55	77	2.60	-0.27	0.30	0.69	0.91
13	AR5X36	51	74	2.58	-0.20	0.29	0.63	0.94
14	AR7X50	50	74	2.32	-0.36	0.15	0.92	0.91
15	AR6X37	54	72	1.70	-0.40	0.16	0.51	0.50
16	MK6X74	52	67	1.68	-0.13	0.26	0.32	0.43
17	MK6X75	46	83	3.65	-0.40	0.09	2.58	1.83
18	AR5X37	47	81	3.48	-0.37	0.12	2.14	1.74
19	MK6X77	44	70	3.02	-0.13	0.26	0.70	1.38
20	AR7A53	44	62	1.58	-0.20	0.09	0.47	0.52
21	MK6X78	45	59	1.53	0.03	0.20	0.28	0.39
22	MK5X74	41	59	3.61	0.15	0.35	0.15	1.24
23	MK5X73	35	75	3.68	-0.27	0.08	2.20	2.40
24	AR7X37	38	64	3.35	-0.02	0.26	0.50	1.67
25	AR6E36	39	63	3.61	0.04	0.30	0.33	1.69
26	MK7X76	38	58	2.27	0.04	0.19	0.45	0.86
27	MK7X80	37	53	3.11	0.23	0.30	0.15	0.93
28	AR5X38	36	54	3.72	0.18	0.31	0.13	1.33
29	MK5X83	38	54	1.70	0.10	0.15	0.34	0.51
30	AR5X39	34	61	3.03	-0.05	0.17	0.74	1.65
31	AR7A55	34	57	2.23	-0.05	0.10	0.69	1.03
32	AR6X40	34	52	2.51	0.20	0.23	0.26	0.83
33	AK5X79	32	50	1.99	0.17	0.14	0.37	0.69
34	AR6E42	31	45	4.02	0.28	0.28	0.06	1.14
35	AR7X40	27	52	3.14	0.09	0.16	0.48	1.68
36	AR7E37	29	45	3.54	0.28	0.25	0.10	1.10
37	MK7X78	29	42	2.62	0.43	0.23	0.11	0.58
38	AR6X44	23	42	2.83	0.25	0.14	0.30	1.18
39	MK5X87	23	42	2.87	0.26	0.14	0.29	1.20
40	AR7A85	23	41	1.96	0.28	0.07	0.39	0.74
41	AR6X43	21	36	3.74	0.34	0.18	0.09	1.18
42	MK5X82	24	34	3.68	0.45	0.22	0.04	0.65
43	AR5X42	22	34	3.65	0.42	0.19	0.06	0.85
44	AR6E44	19	50	4.51	0.07	0.13	0.44	3.69
45	AR6X41	19	47	3.74	0.10	0.10	0.56	2.66

Table 6. Characteristics of math items in Form B

Item	Code	Percentage correct		IRT parameters			Information	
		31	50	a	b	c	31	50
1	MK5X90	77	91	2.39	-0.89	0.19	0.88	0.43
2	AR7X34	76	91	2.58	-0.77	0.26	0.97	0.50
3	AR7E34	76	88	1.63	-1.10	0.13	0.44	0.28
4	AR7X36	61	83	2.94	-0.33	0.37	0.79	0.95
5	AR6X50	59	88	3.56	-0.48	0.20	2.08	1.26
6	AR7X35	57	81	2.71	-0.41	0.23	1.08	0.98
7	AR6X49	58	79	2.68	-0.27	0.35	0.65	0.87
8	AR7E35	55	83	3.09	-0.43	0.18	1.59	1.24
9	AR5X35	53	84	3.44	-0.42	0.17	1.97	1.46
10	AR7A24	53	78	2.69	-0.35	0.21	1.04	1.07
11	AR7A38	54	76	2.05	-0.49	0.09	0.88	0.73
12	MK7X74	51	69	2.39	-0.02	0.36	0.31	0.68
13	AR6X38	48	74	2.60	-0.31	0.16	1.06	1.13
14	AR7A40	49	74	2.28	-0.39	0.09	1.05	0.94
15	AR7X38	49	71	2.55	-0.17	0.27	0.62	0.96
16	AR7E40	46	73	3.45	-0.13	0.31	0.66	1.63
17	MK7X73	42	79	3.68	-0.31	0.13	2.09	2.07
18	AR7X42	43	61	2.38	0.07	0.28	0.32	0.76
19	AR7A69	45	61	1.49	-0.20	0.09	0.42	0.46
20	AR7E36	42	55	2.17	0.29	0.31	0.15	0.46
21	MK5X75	39	79	3.68	-0.35	0.04	2.83	2.18
22	AR7A54	39	68	3.32	-0.12	0.21	0.87	1.83
23	AR6X36	39	66	2.75	-0.12	0.18	0.79	1.34
24	AR6X39	40	62	2.17	-0.12	0.13	0.67	0.92
25	AR7E38	38	57	3.09	0.15	0.30	0.22	1.08
26	AR7A56	36	57	2.37	0.06	0.19	0.44	0.93
27	AR5X41	35	50	2.88	0.31	0.29	0.12	0.72
28	AR7X39	35	50	2.38	0.32	0.26	0.16	0.59
29	MK5X77	34	70	3.34	-0.22	0.08	1.73	2.16
30	AR7A70	34	55	2.05	0.02	0.11	0.54	0.84
31	AR5X40	33	48	1.93	0.30	0.19	0.23	0.52
32	AR7E39	33	47	3.79	0.28	0.29	0.07	1.07
33	AR6E37	33	47	3.82	0.30	0.30	0.06	0.96
34	AR6E39	29	56	4.51	0.07	0.23	0.26	2.93
35	AR7E41	28	50	4.51	0.15	0.24	0.14	2.36

Table 6. (Continued)

Item	Code	Percentage correct		IRT parameters			Information	
		31	50	a	b	c	31	50
36	AR7X43	27	46	1.93	0.19	0.08	0.43	0.74
37	AR7X44	25	42	3.09	0.30	0.19	0.17	1.07
38	AR6E46	26	43	2.10	0.28	0.11	0.34	0.75
39	AR7A71	22	41	3.54	0.25	0.17	0.18	1.51
40	MK5X80	23	36	3.56	0.39	0.20	0.07	0.91
41	MK6X88	23	35	3.68	0.39	0.20	0.06	0.92
42	AR7E44	25	36	3.34	0.47	0.22	0.05	0.61
43	AR6E43	21	32	3.03	0.51	0.17	0.07	0.61
44	AR7E42	17	31	3.68	0.36	0.13	0.11	1.32
45	AR7X46	15	28	3.44	0.44	0.12	0.10	1.01

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